Randomness has saved Leonov from death again in 1971. Then he was appointed commander of the primary crew of "Soyuz-11", but before the start it was decided to send the backup crew Dobrovolsky, Volkov and Patsaev. All three died during the descent from orbit.

10 years after his spacewalk Leonov (Fig. 6) went into its second flight. He was the commander of "Soyuz-19". This time it was the first in the history of the docking of two spacecraft from different countries, flight "Soyuz - Apollo" [2].

Figure 6 - Alexei Leonov - Soviet cosmonaut, first man to walk in space.
Twice Hero of Soviet Union

In addition to their main profession, Alexei Leonov, who last year celebrated its 80th anniversary, has become famous in our country and as a painter which promotes space exploration. In particular, the three sets of postage stamps were issued, for which Leonov created drawings.[3]

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Oxygen Supply on a Spaceship

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Life support systems in spacecraft are designed to provide a safe, habitable environment for the astronauts, and one of the most significant challenges is managing acceptable air quality. For example, CO_2 is respired normally by humans at concentrations that are toxic if inhaled directly. As a result, the cabin air must be tightly managed, with CO_2 levels kept below 0.5% at maximum, and preferably below 0.1% for the optimal safety and comfort of the crew.

NASA currently uses a complex pressure swing absorption system on the International Space Station (ISS), which operates at relatively high power (1 kW necessary for absorption bed regeneration), and is significantly larger and more massive than desired for space deployment. Further, current systems have demonstrated poor reliability in the field, with significant shutdown events on the ISS occurring in the carbon dioxide scrubbing system in 2009, and in an oxygen generation system in 2011.

The underperformance of air purification technology is considered to be a significant impediment to longer term endeavors such as a mission to Mars or space habitation. Current, proposed, and future NASA missions will extend the amount of time humans spend in sealed space environments, creating an absolute requirement for improvements in the performance of life support systems, including their weight, footprint, and energy consumption, with simplified designs that eliminate mechanical and electrical failure mechanisms.

PHASE I RESULTS

The goal of this Phase I NASA-funded project was to establish the proof of concept of electrochemical gas separation using eSionic's liquid membrane and to provide significant advances to establish the potential for liquid membranes to revolutionize space-deployed life support systems, including:

· Experimental validation that electrochemical transport using a composite liquid membrane will extract carbon dioxide from simulated cabin air to below 0.5%, and measurement of the throughput of this system Detailed trade analysis based on the experimentally determined CO2 fluxes, culminating in an estimation of the required size and weight of a system used to clean the air of the ISS (as a benchmark), as well as a comparison of the size and energy use of this technology to currently available CO2 scrubbing systems.

· Phase I goals for this program were successfully accomplished through a program of system modeling, membrane synthesis and fabrication development, and optimization of carrier concentration and mass transport properties in a composite membrane film [1].

COMPARISON AND SYSTEM ADVANTAGES TO CURRENT SYSTEM

There is a significant trade-off, however, between the desire to keep carbon dioxide levels below the threshold where the air turns toxic, and the opposing desire to minimize the size and energy consumption of air revitalization equipment. On the International Space Station, a single carbon dioxide removal assembly (CDRA) is capable of maintaining cabin air at torr <5.3 CO_2 for up to 9 crew members [3], although studies have shown that optimally CO_2 concentrations should be kept below 4 torr. [4]. Consistent maintenance of CO_2 at this lower level, or operation at times of heavy CO_2 load such as at shuttle docking, require the operation of a second CDRA unit.

Under normal operating conditions, the CDRA consumes about 2.1 kWh per kg of CO_2 removed; [5] for a typical six-member crew, this imposes a cost of approximately 12-15 kWh per day of operation. This is a substantial load, high enough that continuous operation of more than one CDRA unit is simply not practical [4]. Realistically, the energy consumption required for CO_2 purification today is so high that missions must operate at the limits of human CO_2 tolerance, and spacecraft power systems are designed around the constraints imposed by the revitalization units.

Surprisingly, 80% of the power consumption of the CDRA arises not from the CO_2 separation process itself, but from a pre-treatment step where the air is dried to ensure the CO_2 sorption beds are effective. The step of drying the air is not rigorously necessary, as downstream units such as the Sabatier process are water tolerant, and in fact create water as a reaction product and collect it in their own subsystems. However, there is no CO_2 sorbent technology today that can separate CO_2 without this drying step, and still meets NASA criteria for reliability and cabin compatibility.

An efficient, water tolerant and mission-compatible replacement to the existing CDRA system could reduce its energy consumption five-fold, enabling improvements in cabin air quality and freeing significant (10 kWh per day) energy for other mission needs.

The CDRA in the International Space Station is constructed with two parallel purification channels, each with a desiccant unit comprised of 13X zeolite and silica gel and an absorber comprised of 5A zeolite, as shown schematically in Figure 1. The cabin air flows over the desiccant in a first channel to remove moisture, and then flows over the 5A zeolite where the CO_2 is captured. Once the sorption chambers are near saturation, the channel switches to regeneration mode, and the system is heated to release the water and the carbon dioxide, which are recaptured as separate streams. While the first channel is in regeneration mode, the flow of cabin air is directed to the second channel, so that purification can be carried on continuously despite the batch nature of the capture process.

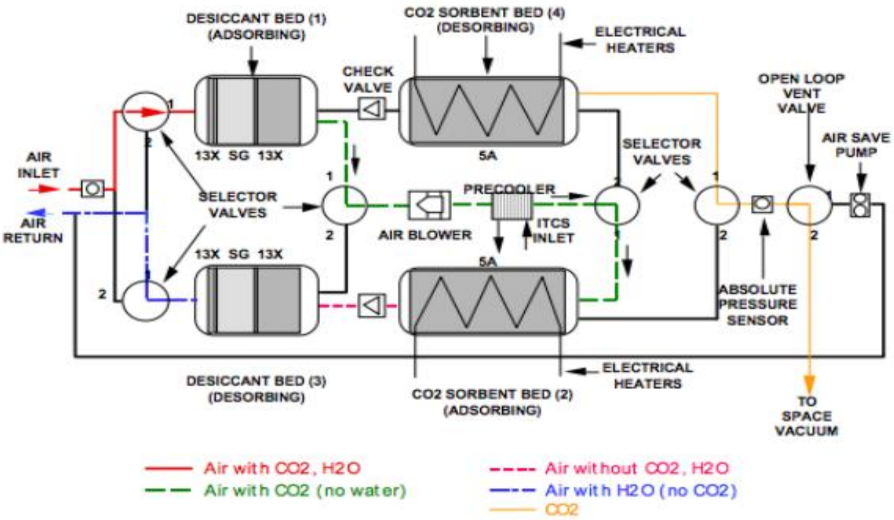

Figure 1 - A schematic of the ISS CDRA.19 In this approach, the collected CO2 is vented directly into space to remove it from the cabin

In this original carbon capture design, the zeolite concentrated the CO_2 from 99% purity in a single stage, and the practice of venting the CO_2 into the vacuum of space minimized the total energy requirements for air revitalization, yet did not sacrifice any of the other cabin gases because the CO_2 uality was so high. However, the long term nature of the ISS mission, as well as future NASA missions, made it desirable to keep this gas on the vessel rather than exhaust a steady stream off board.

The Sabatier reaction is a continuous process where CO_2 from the CDRA is fed into the reactor, reacting with H_2 created by water electrolysis. Rather than vent gas into space as performed in previous implementations of the CDRA, the purified CO_2 is instead passed into this reactor to recapture the oxygen atoms from CO_2 and recirculate them into the cabin as water. Because the CDRA creates CO_2 in a batch process, the CO_2 must be pressurized and held in a CO_2 accumulator so that it can be slowly and continuously fed into the Sabaiter reactor. Water produced during the reaction is collected on a cold plate and separated from the methane, which is vented into space or collected as a fuel for subsequent use. The Sabatier reaction operates at high temperature, which is maintained in part using heat extracted from this exothermic reaction.

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CONCLUSIONS

Phase I demonstrated the functionality of eSionic's approach to CO_2 separation: we have established that CO_2 can be removed from simulated cabin air using only electrical input, by a film in a membrane configuration. Membrane synthesis and fabrication techniques were developed that allowed for the successful incorporation and retention of an electrochemically active carrier molecule with eSionic's composite liquid membrane technology. This allowed for the successful demonstration of a continuous CO_2 capture rate at 40% in a single step with no moving parts. Higher capture rates of 80% was also demonstrated in a batch mode during this phase, showing the feasibility of this technology for highly efficient, low energy separation of CO_2 in space exploration activities. Based on these results and efforts during this phase of the program, it is projected that this technology has the potential of replacing the current CRDA on-board ISS with an operational energy savings of 80% in a weight and size footprint that is 75% smaller. eSionic's key enabling technology – composite liquid membrane materials – allows creation of a functional electrochemical membrane in a thin film form factor that enables this technology and application. The next step in the development is to improve the reliability of electrochemical membranes such that they can be deployed in the field. In Phase II, we will demonstrate the reliability of our system to continuous operation in humid air and we will develop a full system for a prototype air purifier.

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Estimation of the Gas-Dynamic Bearing Static Characteristics for Ball Gyroscope

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Gas-dynamic bearing is the support, where spike and bearing completely separated by a gas layer. Bearing capacity is formed due to the appearance of the high pressure in the zone of small gaps. The high pressure causes the appearance of the resulting lift force, which is counterbalanced of spike mass. The lubricant in such supports is air or gas [1].

Application of gas-dynamic bearing (GDB) is mainly determined by the features, which characterize natural gas lubrication [2]. Gas has a low viscosity. Ambient temperature has a little influence on it. Ambient pressure has even smaller impact on viscosity. Such stability of gas viscosity and its small quantity opens a wide range of applications for devices, which operate at high speeds in a wide range of operating temperatures. Gas-bearing also may be used in areas of